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RESEARCH PAPER

Potential anti-oxidative properties and quality characteristics of Korean traditional rice cake added with black soybean (*Rhynchosia nulubilis*) as inner beauty material in COVID-19 pandemic

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Abstract

Humans have a great desire to live a long and healthy life, but as they age, their physical functions weaken and they cannot live long and healthy due to problems such as eating habits and lifestyle. Therefore, in this study, 0%, 5%, 10%, 15% and 20% of black soybeans with high protein content and high antioxidant power were added to rice cake, a traditional Korean food, to compare quality characteristics, antioxidant effect, and preference survey. As a result of the experiment, as the content of black beans increased, the moisture content and pH decreased, and the color and texture were slightly different. In addition, the contents of polyphenols and flavonoids increased significantly. ABTS radical scavenging activity also showed a significant increase, with values of 15.37 ± 3.63 ($p < 0.01$), 36.23 ± 2.00 ($p < 0.001$), 63.90 ± 3.82 ($p < 0.001$), and 78.75 ± 1.00 ($p < 0.001$). Similarly, DPPH radical scavenging activity significantly increased to 7.91 ± 2.92, 14.59 ± 1.91 ($p < 0.01$), 17.37 ± 1.46 ($p < 0.001$), and 31.54 ± 1.05 ($p < 0.001$). Meanwhile, sensory evaluation results indicated that as the black soybean content increased, overall preference decreased. Therefore, the optimal addition level was determined to be between 5% and 10%. Therefore, if the moisture content is increased, it is expected to be an inner beauty food and health functional food that can satisfy functionality and palatability, and it is judged to be helpful in the COVID-19 pandemic.

Keywords

Anti-oxidative properties, Black soybean (*Rhynchosia nulubilis*), COVID-19 pandemic, lnner beauty material, Korean Traditional Food, Rice cake

Introduction

With the development of medical science around the world, the average life expectancy has increased to more than 100 years, and the elderly population has increased, leading to an aging society. However, as disease has become a social problem due to problems such as improper diet and lifestyle, the efficacy of various bio-functional substances contained in fruits, vegetables, beans and grains is attracting attention. Accordingly, as interest in healthy life, health, and (anti)aging has greatly increased, research on natural antioxidants and anti-inflammatory substances that can prevent aging and inflammatory diseases is being actively conducted (Branen 1975; Hong et al. 2014; Choi et al. 2017).

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Moreover, at the end of December 2019, with the first report of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Wuhan, China, the COVID-19 pandemic caused changes in people's lives, habits, and eating habits (Hui et al. 2020; Zhu et al. 2020). With COVID-19, food and eating habits are key determinants of health. In particular, nutrients from natural food are beneficial to fight the disease without side effects to the body (Lindgren et al. 2018; Covinsky and Katz 2020). Studies have shown that bioactive components such as flavonoids and polyphenols found in fruits, vegetables and plants can reduce lung damage and have protective effects against lung infections by acting as immune modulators and inflammatory mediators (Gentile et al. 2012; Cianciosi et al. 2018). As a result, antioxidants may be beneficial against COVID-19, and it is necessary to consider foods and nutritional components that can improve health care and the ability of the immune system (Carr and Maggini 2017; Grant et al. 2020; Soto et al. 2020).

In addition, recently, as the number of consumers who want to manage their health through food increases, research on inner beauty food using functional foods has been in the spotlight among consumers (Jung et al. 2019). Inner beauty is also called 'eating cosmetics', meaning that it prevents and improves skin aging through my eating habits and lifestyle, rather than just thinking about the skin in an artificial way and temporarily improving it (Lee et al. 2017). Therefore, it is necessary to consume and practice foods and functional foods with antioxidant effects. There are antioxidants in rice, and it is considered to show antioxidant function because it contains polyphenol compounds caffeic acid, p-coumaric acid, sinapic acid, ferulic acid and functional ingredients polyphenolics, flavonoids ɣ-oryzanol and phytic acid. It also contains magnesium (selenium, iron, phosphorus) and vitamin E (thiamine, niacin, folic acid) (Baublis et al. 2000; Qureshi et al. 2000; Kim et al. 2001; Ravichanthiran et al. 2018). Among leguminous crops, black soybean is a kind of black soybean, which is smaller and shinier than *Seoritae*. In Korea, it is also called *Seomoktae* or *Yak bean* or *Jinuni bean*. Because it is similar to the eye of a mouse. The size of the seed is 5–7 mm, harvested in October, and it is a native variety of East Asia and contains more than 40% of protein (Liao et al. 2005; Kim et al. 2006; Lim 2010). It also contains many biologically active compounds such as lecithin, trypsin inhibitors, phytates, phytosterols, and saponins, as well as vitamins and minerals (Kang et al. 2003; Lim et al. 2009). The seed coat of black soybean is black and is an anthocyan pigment, and the skin contains a large number of polyphenols, so it has an excellent antioxidant effect. In oriental medicine and traditional Chinese medicine, it is known to be good for the kidneys and is said to be used for detoxification, anti-inflammatory and Improvement of blood circulation (Fiat et al. 1993; Choi et al. 2005; Liao et al. 2005; Yim et al. 2009). Also, black soybean has a high content of isoflavones, which is 19.5 times higher than that of other black beans. It is known to be useful for preventing and treating diseases such as hypertension, diabetes, age-related diseases, anti-aging, osteoporosis, anti-nociceptive, anti-inflammatory effect and senile dementia (Setchell and Cassidy 1999; Tsangalis et al. 2002; Pham and Shah 2007; Lim et al. 2009; Yim et al. 2009). Concentration of the physiologically active components of black soybeans has been reported to have anticancer, anti-obesity, anti-diabetic, anti-mutagenic and anti-osteoporosis effects in other papers as well (Hung et al. 2007; Kim et al. 2011; Kim et al. 2012; Chen et al. 2013) and has also been shown to be associated with a reduced risk of cardiovascular disease.12 black soybean were found to reduce the risk of breast cancer in Korean women when consumed, and the recurrence rate of breast cancer was also lowered when soy protein and isoflavones were consumed regularly (Do et al. 2007; Shu et al. 2009). However, there are proteolytic inhibitors in soybeans, so it must be eaten cooked, and if consumed raw, it interferes with the absorption of soy protein and interferes with digestion. In addition, when heat is applied, trypsin inhibitor is inactivated to enhance digestion and absorption of soy protein and improve texture (Anderson and Wolf 1995). AEND and GCDN (2020) recommends eating a variety of grains and legumes, including rice, which may be helpful during the COVID-19 pandemic.

In Korea, in general, black soybean are eaten with rice, or used for *Gangjeong*, rice cakes, soymilk, soybean noodle soup, bean meat, side dishes etc. In addition to food, they are widely used in cosmetics and pharmaceuticals. However, there has been no research on rice cakes using black soybean, so the experiment was conducted by adding black soybean, which are health functional foods and have protein and antioxidant effects. The purpose of this study is to develop black bean rice cakes as a health functional food that can help with the worldwide serious COVID-19 pandemic and aging problems. Therefore, in this study, quality evaluation, antioxidant activity and sensory evaluation of rice cake were conducted by adding black soybean to rice cake, a traditional Korean food. The study of black soybean and rice cake, a traditional Korean food, is expected to have added value, and it will attract the attention of consumers and be helpful at home in COVID-19 pandemic. There is a need to research and develop various foods using black soybeans, which are functional foods in the future.

Materials and methods

Materials

The rice used in the experiment was white rice from Buyeo-gun, Chungcheongnam-do (Company: Buyeo-nh nonghyup) and was purchased from Jayeonae Mart. Black soybeans (Company: Daechan Farmhouse, Origin: Hamyeong-gun, Gyeongnam) were ordered online and used. For water, Jeju City (Company: Samdasoo), white sugar (CJ Cheiljedang Co., Ltd., Buyeo-gun,

Republic of Korea), and sea salt grilled salt (Company: Chungjungwon, Shinan-gun, Republic of Korea) were used. In the experiment, only white rice, black soybeans, water, white sugar, and salt were used, and 5 types of rice cakes were made with black soybeans at 0%, 5%, 10%, 15%, and 20% ratios.

Production of Korean rice cake

Rice was finely ground twice using a roll-mill and passed through 20 mesh once. Next, add black soybean powder, water and salt, mix, pass through a 20-mesh sieve, add sugar and mix evenly. The mixed ingredients are put in a steamer and steamed for 25 minutes, then wrapped in plastic wrap and frozen. Wash the black soybeans twice, drain the water from the sieve, put the black soybeans in a frying pan, stir-fry them over high heat, cool them for 2 hours, then grind them with a grinder (NC_211). Rice cake made with black beans is shown in Fig. 1.

Measurement of water content

After crushing the sample in a mortar and pestle, 1 g was weighed and measured with a moisture measurement analyzer (MB45, Ohaus, Parsippany, NJ, USA) (Han 2023).

Measurement of pH

After adding distilled water 10 times the weight of the sample, it was homogenized with a homogenizer, and the supernatant was measured with a pH meter (pH-240L, NeoMet, Istek, Seoul, Republic of Korea) (Han 2023).

Measurement of chromaticity

Lightness, redness, and yellowness were measured using a Minolta chroma meter (CR-400, Minolta Co., Osaka, Japan) (Han 2023).

Figure 1. Sift the rice flour ground in a roll mill through a 20 mesh once (**a**), Add black bean powder, salt, sugar, and water to sieved rice flour, mix and sift (**b**), The mixed ingredients are put in a steamer and steamed (**c**), After cooling down, wrap it (**d**) (Source: own photo).

Measurement of texture

It was measured in the downward direction (right angle) from the top of the sample using a measuring instrument Instron 3343 (US/MX50, A&D Co., MA, USA) (Han 2023).

Antioxidant effect of Korean rice cake supplemented with black soybean sample extraction

The ground sample and distilled water were put into an Erlenmeyer flask and mixed well. After extracting the components in a water bath (BS-31, JEIO TECH.CO., LTD, Seoul, Republic of Korea) and centrifuging, the supernatant was taken and used for the measurement of antioxidant activity (Han 2023).

Total phenol and flavonoid contents

It was measured by modifying the Foline-ciocalteau method of (Taga et al. 1984). Samples diluted by concentration were placed in a test tube, 1 N Folin-Ciocalteu Reagent was added and mixed well. After adding 700 mM Na2CO3, the mixture was reacted at room temperature for 30 minutes, and the absorbance was measured at 650 nm using a UV spectrophotometer (Optizen POP, Mecasys CO., LTd, Daejeon, South Korea). The content of total polyphenols was calculated using gallic acid (G7384-100G, Sigma-Aldrich, St Louis, MO, USA) as a standard material (Han 2023).

It was measured by applying the method of (Zhishen et al. 1999). Samples diluted by concentration were put in a test tube, 5% NaNO2 was added, and reacted at room temperature. Then, 10% AlCl3 was added, 1 N NaOH was added, reacted at room temperature, and absorbance was measured at 492 nm using a UV spectrophotometer (Optizen POP, Mecasys CO., LTd, Daejeon, South Korea). The total flavonoid content was determined using Quercetin (Q4951-10G, Sigma-Aldrich, St Louis, MO, USA) as a standard material (Han 2023).

ABTS radical scavenging activity

The method of (Re et al. 1999) was modified and measured. After mixing 7 mM ABTS and 140 mM potassium persulfate, ABTS cations were formed by blocking light at room temperature for 16 hours. After mixing the ABTS solution and the sample and reacting at room temperature, the absorbance was measured at 734 nm using a Versamax microplate reader (Molecular Devices, California, USA) (Han 2023).

DPPH free-radical scavenging activity

It was measured according to the method used by (Hatano et al. 1989). After mixing the sample and the DPPH (0.15 mM 1,1-diphenyl-2-picrylhydrazyl (DPPH)/ethanol) solution, the mixture was reacted at room temperature for 30 minutes, and the absorbance was measured at 517 nm using a Versamax microplate reader (Molecular Devices, California, USA) (Han 2023).

Sensory evaluation

Major of Rice Cake Manufacturing Management and Major of Medicinal Crop in Sungkyul University, Anyang, Republic of Korea A sensory test was conducted on a total of 10 subjects and evaluated on a 5-point scale (Han 2023).

Statistical analysis

Using Excel 2020 (Microsoft, Redmond, WA, USA), the average and standard deviation of the analysis data were obtained, and the paired t-test was performed, and it was determined that there was a statistically significant difference when the significance probability $p < 0.05$ in the 95% confidence interval (Han 2023).

Results and discussion

Physicochemical properties of Korean Rice cake added with black soybean

The water content, pH, chromaticity and texture of Korean rice cake supplemented with black soybean are shown in Table 1. The water content of the Korean rice cake supplemented with black soybean was 39.31 ± 0.17 when black soybean content was 0%, while it was 37.86 ± 0.27 ($p < 0.01$), 37.48 ± 0.23 ($p < 0.001$), 35.24 ± 0.05 ($p < 0.001$) and 33.7 ± 0.19 ($p < 0.001$) at 5%, 10%, 15% and 20%. The pH was 7.36 ± 0.02 when the black soybean content was 0%, while it was 7.03 ± 0.01 ($p < 0.001$), 6.88 ± 0.02 ($p < 0.001$), 6.7 ± 0.02 ($p < 0.001$) and 6.66 ± 0.02 ($p < 0.001$) at 5%, 10%, 15% and 20%. The pH appeared to be highest in the control group, indicating that the pH decreased as the amount of ingredients added to black soybeans increased. The L value was 85.1 ± 1 when the black soybean content was 0%, while it was 66.4 ± 1.9 ($p < 0.001$), 63 ± 1.3 ($p < 0.001$), 57.4 ± 0.8 ($p < 0.001$) and 54.9 ± 2.2 ($p < 0.001$) at 5%, 10%, 15% and 20%. If the L value was the highest in the control group, it was shown to decrease as the content of black soybeans increased. The a value, which indicates redness, was -1 ± 0.1 when the black soybean content was 0% while it was 2.6 ± 0.2 ($p < 0.001$), 3.3 ± 0.1 ($p < 0.001$), 4.1 ± 0.3 ($p < 0.001$), and 4.5 ± 0.3 ($p < 0.001$) at 5%, 10%, 15% and 20%. The a value was the lowest in the control group and gradually increased. The b value, which indicates yellowness was 7.7 ± 0.2, when the Black soybean content was 0%, while it was 13.8 ± 0.7 ($p < 0.001$), 15 ± 0.3 ($p < 0.001$), 16.7 ± 0.3 ($p < 0.001$) and 16.9 ± 0.4 ($p < 0.001$) at 5%,

10%, 15% and 20%. The b value showed a large difference when increasing the concentration of 5% in the control group, but gradually increased. We confirmed the difference in viscosity of rice cakes with black soybeans added. The Hardness 0.33 ± 0.02 when the black soybean content was 0%, while it was 0.29 ± 0.23, 0.31 ± 0.09, 0.24 ± 0.02 ($p < 0.01$) and 0.28 ± 0.01 ($p < 0.01$) at 5%, 10%, 15% and 20%. The hardness seemed to decrease as the content of black soybeans increased, but there was a slight difference by concentration. The cohesiveness 0.53 ± 0.05 when the black soybean content was 0%, while it was 0.69 ± 0.23, 0.5 ± 0.04 ($p < 0.001$), 0.39 ± 0.12 and 0.25 ± 0.01 ($p < 0.001$) at 5%, 10%, 15% and 20%. Cohesive force increased as the content increased in the control group, but decreased from 10%, showing a lower value than the control group. The springiness 1 ± 0.01 when the black soybean content was 0%, while it was 1.46 ± 0.44, 1.11 ± 0.15, 1.08 ± 0.08 and 1.02 ± 0.08 at 5%, 10%, 15% and 20%. Springiness appeared to increase from the 5% concentration but gradually decreased. The gumminess 0.18 ± 0.03 when the black soybean content was 0%, while it was 0.2 ± 0.06, 0.16 ± 0.05, 0.09 ± 0.03 ($p < 0.01$) and 0.07 ± 0.01 ($p < 0.001$) at 5%, 10%, 15% and 20%. The chewiness 0.18 ± 0.02 when the black soybean content was 0%, while it was 0.3 ± 0.17 ($p < 0.001$), 0.17 ± 0.04 ($p < 0.001$), 0.1 ± 0.03 ($p < 0.001$) and 0.07 ± 0.01 ($p < 0.01$) at 5%, 10%, 15% and 20%. Gumminess and chewiness were shown to increase at the 5% concentration but gradually decreased. The adhesiveness 0.08 ± 0.02 when the black soybean content was 0%, while it was 0.08 ± 0.03, 0.12 ± 0.05, 0.08 ± 0.02 and 0.08 ± 0.01 at 5%, 10%, 15% and 20%. Adhesiveness was higher at the 5% concentration, but other samples were similar. Korean rice cakes with different amounts of black bean powder are shown in Fig. 2.

Analysis of total phenol and flavonoid contents in Korean rice cake supplemented with black soybean

The total phenol and flavonoid content of Korean rice cake supplemented with black soy bean are shown in Table 2. The total phenol con-tent was 45.5 ± 14.42 at 0%, while it was 115.57 ± 0.18 ($p < 0.001$), 187.99 ± 3.4 ($p < 0.001$), 455.9 ± 14.67 ($p < 0.001$) and 689.98 ± 18.28 ($p < 0.001$) at 5%, 10%, 15% and 20%, respectively, showing a significant increase. It was reported that the total polyphenol content of rice cake without aronia powder was 4.55 mg GAE/g, but the total polyphenol content of rice cake without black soybean powder in this experiment was 45.50 μg GAE/g. Therefore, it was confirmed that there was a 10-fold difference in the experimental results of each study (Hwang and Hwang 2015). According to the study, rice also reported antioxidant function, but as a result of this experiment, it is expected that there will be a difference in the content of polyphenols and flavonoids depending on the country of origin and the method of making rice cakes. Also, present in soybeans, the most important phenolic compounds are one of the family of phytochemicals. Because of their antioxidant activity, these molecules play an important role in human health and are associated with anti-diabetic and anti-obesity, anti-inflammatory, and anti-cancer properties (Ganesan and Xu 2017). And another study confirmed that black soybean skins had strong antioxidant effects and were high in total polyphenols (Sa et al. 2003). In addition, anthocyanin contained in black soybean skin and inside is an antioxidant and synergistic effect with phenolic substances, which is an important source (Choung et al. 2001; Tsoyi et al. 2008). When roasted using black soybeans, the polyphenol in the non-roasted control group was 0.39 mg/g, and one sample roasted at 120 °C was found to be 0.75 mg/g, and flavonoid levels

Table 1. Changes in water content, pH, chromaticity and Texture of rice cake supplemented with black soybean.

	Concentration (%)				
	0	**5**	**10**	**15**	**20**
Water content[1)]	39.31 ± 0.17	37.86 ± 0.27***	37.48 ± 0.23***	35.24 ± 0.05***	33.7 ± 0.19***
pH[1)]	7.36 ± 0.02	7.03 ± 0.01***	6.88 ± 0.02***	6.70 ± 0.02***	6.66 ± 0.02***
	L 85.10 ± 1.00	66.4 ± 1.90***	63.0 ± 1.30***	57.4 ± 0.80***	54.9 ± 2.20***
	a -1.00 ± 0.10	2.60 ± 0.20***	3.30 ± 0.10***	4.10 ± 0.30***	4.50 ± 0.30***
Chromaticity[1)]	b 7.70 ± 0.20	13.8 ± 0.70***	15.0 ± 0.30***	16.7 ± 0.30***	16.9 ± 0.40***
	w 62.10 ± 1.10	25.10 ± 3.80***	18.10 ± 1.70***	7.10 ± 1.80***	4.30 ± 1.80***
	c 7.70 ± 0.20	14.00 ± 0.70***	15.30 ± 0.30***	17.2 ± 0.40***	17.4 ± 0.40***
	h 97.6 ± 0.4	79.45 ± 0.30***	77.7 ± 0.40***	76.3 ± 0.70***	75.1 ± 0.90***
Hardness	0.33 ± 0.02	0.29 ± 0.05	0.31 ± 0.09	0.24 ± 0.02**	0.28 ± 0.01**
Cohesiveness	0.53 ± 0.05	0.69 ± 0.23	0.5 ± 0.04	0.39 ± 0.12	0.25 ± 0.01***
Springiness	1.00 ± 0.01	1.46 ± 0.44	1.11 ± 0.15	1.08 ± 0.08	1.02 ± 0.08
Gumminess	0.18 ± 0.03	0.20 ± 0.06	0.16 ± 0.05	0.09 ± 0.03**	0.07 ± 0.01**
Chewiness	0.18 ± 0.02	0.30 ± 0.17	0.17 ± 0.04	0.10 ± 0.03**	0.07 ± 0.01**
Adhesiveness	0.08 ± 0.02	0.08 ± 0.03	0.12 ± 0.05	0.08 ± 0.02	0.08 ± 0.01

[1)] Mean ± SD.
* $p < 0.05$: Means in a column are significantly different at 5% significance level by t-test.
** $p < 0.01$: Means in a column are significantly different at 1% significance level by t-test.
*** $p < 0.001$: Means in a column are significantly different at 0.1% significance level by t-test.

Table 2. Total phenol and total flavonoid contents of rice cake supplemented with black soybean.

	Concentration (%)				
	0	**5**	**10**	**15**	**20**
Total phenol[1)]	45.5 ± 14.42	115.57 ± 0.18***	187.99 ± 3.4***	455.9 ± 14.67***	689.98 ± 18.28***
Total flavonoid[1)]	-2.63 ± 2.56	-6.53 ± 2.56	23.87 ± 5.02***	203.53 ± 10.23***	430.61 ± 26.31***

[1)] Mean ± SD.
* $p < 0.05$: Means in a column are significantly different at 5% significance level by t-test.
*** $p < 0.001$: Means in a column are significantly different at 0.1% significance level by t-test.

Figure 2. Korean rice cakes with different amounts of black bean (*Rhynchosia nulubilis*) powder added (Source: own photo).

were also confirmed to increase (Lee et al. 2014). These results are believed to have been generated by the Maillard reaction, and we intend to judge that it is due to the increase in melanoidin, a brown reaction product (Do et al. 1989). Because black soybeans used in this experiment were also used after roasting in a pan, it is judged that the polyphenol and flavonoid levels increased. Total flavonoid con-tent was -2.63 ± 2.56 at 0%, while it was -6.53 ± 2.56, 23.87 ± 5.02 ($p < 0.001$), 203.53 ± 10.23 ($p < 0.001$), and 430.61 ± 26.31 ($p < 0.001$) at 5%, 10%, 15% and 20%. In the control group and the concentration of 5%, even though the flavonoid content increased, the level was low, but as the 15% content increased at the 10% concentration, the level of the flavonoid was increased by about 9 times. In addition, 15% black soybean content and 20% black soybean content clearly showed a more than doubled increase in flavonoid levels. We found that rice cake with higher concentration of black soybean had a higher antioxidant effect. Phenolic compounds are widely distributed in the plant kingdom and are one of the secondary metabolites. Because they have a phenolic hydroxyl (OH) group, they are known to exhibit various physiological activities *in vivo* by easily binding to proteins and other macromolecules (Joung et al. 2007; Seo and Lee 2013). Therefore, we believe that the total phenol content and flavonoids are the main causes of the increased antioxidant effect as the black soybean concentration increases, and that the total flavonoid content and flavonoids significantly contribute to the antioxidant effect. The total phenolic compounds contained in black soybeans (Sa et al. 2003) support and establish that the total phenolic content and flavonoid content are as follows. Therefore, the total phenolic content and flavonoid content are closely related to the effectiveness of antioxidants. Lastly, there may be differences in the levels of polyphenols and flavonoids due to the origin and cultivation process of black soybeans, and it is expected that there will be differences in the content of polyphenols and flavonoids depending on the cooking method.

Antioxidant effect of Korean rice cake supplemented with black soybean

The experimental results of ABTS and DPPH methods are shown in Table 3. The antioxidant effect measured by ABTS method was 6.49 ± 0.78 when the concentration of black soybean was 0%, while it was 15.37 ± 3.63 ($p < 0.01$), 36.23 ± 2 ($p < 0.001$), 63.9 ± 3.82 ($p < 0.001$) and 78.75 ± 1.7 ($p < 0.001$) at 5%, 10%, 15% and 20%, show-ing a significant increase compared to that at 0%. With the DPPH method, the antioxidant effect was 6.67 ± 0.25 at 0%, while it was 7.91 ± 2.92, 14.59 ± 1.91 ($p < 0.01$), 17.37 ± 1.46 ($p < 0.001$) and 31.54 ± 1.05 ($p < 0.001$) at 5%, 10%, 15% and 20%, showing a significant increase compared to 0%. According to another study, as a result of analyzing the antioxidant activity by electron donating ability and SOD (superoxide dismutase) like activity to DPPH free radical, it was confirmed that the activity was high in tofu containing black soybeans, and a similar trend was observed in this experiment (Kim and Lee 2007). Therefore, it can be supported by the results of this experiment that antioxidant activity increased as the amount of black soybean added increased. In addition, the free radical scavenging activity of the roasted black soybean samples by the DPPH and ABTS methods increased as the roasting temperature increased, and the polyphenol and total flavonoid content also increased (Lee et al. 2014). In a similar study, it was found that polyphenols, flavonoids, and ABTS levels increased as the amount added increased

Table 3. Antioxidant effect of rice cake supplemented with black soybean.

	Concentration (%)				
	0	5	10	15	20
ABTS (%)[1)]	6.49 ± 0.78	15.37 ± 3.63**	36.23 ± 2.00***	63.9 ± 3.82***	78.75 ± 1.7***
DPPH (%)[1)]	6.67 ± 0.25	7.91 ± 2.92	14.59 ± 1.91**	17.37 ± 1.46***	31.54 ± 1.05***

[1)] Mean ± SD.
* $p < 0.05$: Means in a column are significantly different at 5% significance level by t-test.
*** $p < 0.001$: Means in a column are significantly different at 0.1% significance level by t-test.

Table 4. Sensory evaluation of rice cake supplemented with black soybean.

	Concentration (%)				
	0	5	10	15	20
Color[1)]	3.6 ± 0.10	3.47 ± 0.12	3.37 ± 0.06**	2.57 ± 0.12***	2.53 ± 0.12***
Flavor[1)]	3.23 ± 0.12	3.77 ± 0.06***	3.60 ± 0.10*	3.83 ± 0.06**	3.10 ± 0.10
Texture[1)]	3.63 ± 0.06	3.57 ± 0.06	3.10 ± 0.10**	2.77 ± 0.06***	2.20 ± 0.10***
taste[1)]	3.20 ± 0.10	3.70 ± 0.10**	3.57 ± 0.25	3.37 ± 0.12	2.63 ± 0.12**
Overall preference[1)]	3.17 ± 0.06	3.57 ± 0.06***	3.47 ± 0.06**	3.00 ± 0.10	2.47 ± 0.06***

[1)] Mean ± SD.
* $p < 0.05$: Means in a column are significantly different at 5% significance level by t-test.
** $p < 0.01$: Means in a column are significantly different at 1% significance level by t-test.
*** $p < 0.001$: Means in a column are significantly different at 0.1% significance level by t-test.

when making wheat bread using walnuts and hazelnuts, which are physiologically active substances (Pycia and Ivanišová 2020). Black beans, which are physiologically active substances, also have a very positive effect on antioxidant properties, so adding black beans to rice cakes is beneficial and can be said to be a health food that can satisfy both nutritional and healthy aspects. Due to the corona virus, many people around the world are exposed to unstable daily life and the risk of infection. In this situation, people are thinking about their health and are making efforts to take care of their health and provide food that is beneficial to the body.

Therefore, research results suggest that it is related to COVID-19 and Nrf2, an antioxidant index, and Nrf2 protects against oxidative stress and is associated with antiviral action and immune infection (Mendonca and Soliman 2020). Nrf2 is regulated by a natural substance e.g. berberine, curcumin, epigallocatechin gallate, genistein, quercetin, resveratrol, and sulforaphane, which are mainly found in vegetables and fruits and can be viewed as antioxidants (Bousquet et al. 2020). It was confirmed that the black bean seed coat was rich in isoflavone glycitein, which has excellent antioxidant effect, and also had a high content of cyanidin-3-glucoside. It also contains daizein and glycitein, which is known to reduce ROS levels by removing and inhibiting intracellular free radicals (Kennedy 1995; Hassan et al. 2020; Mendonca and Soliman 2020). In addition, (Takahashi et al. 2005) reported that (*Rhynchosia nulubilis*), the type of black bean used in this experiment, showed much stronger antioxidant activity than general black beans and yellow beans. Accordingly, it shows that the soybean peptide Nrf2 signal has the effect of inhibiting hydrogen peroxide-induced oxidative stress in HepG2 cells, suggesting that it will help in the Covid-19 era by increasing the body's immunity in the long term (Yi et al. 2020).

Sensory evaluations of Korean rice cake supplemented with black soybean

Results of the sensory evaluation are shown in Table 4. Table 4 shows the sensory evaluation results of Korean rice cake added with black soybean. Evaluation items were evaluated for color, flavor, texture, taste, and overall preference. According to the results of our study, as the black bean content increased, the preference for appearance decreased, and the preference for black soybean rice cake containing 15% was high. In terms of texture and taste, rice cakes with 5% added were preferred, and as the concentration was increased to 10% or higher, they tended to decrease gradually. The overall preference was shown to be good for 5% and 10% concentrations.

Conclusion

Therefore, this paper conducted an experiment and a preference survey on the quality characteristics of rice cakes using black soybeans. As a result of adding black soybeans to rice cakes, the total polyphenol content significantly increased with higher levels of black soybean addition, showing values of 115.57 ± 0.18 ($p < 0.001$), 187.99 ± 3.40 ($p < 0.001$), 455.90 ± 14.67 ($p < 0.001$), and 689.98 ± 18.28 ($p < 0.001$). The total flavonoid content also increased significantly, with values of 23.87 ± 5.02 ($p < 0.001$) at 10% addition, 203.53 ± 10.23 ($p < 0.001$) at 15%, and 430.61 ± 26.31 ($p < 0.001$) at 20%. Furthermore, ABTS radical scavenging activity significantly increased to 15.37 ± 3.63 ($p < 0.01$), 36.23 ± 2.00 ($p < 0.001$), 63.90 ± 3.82 ($p < 0.001$), and 78.75 ± 1.70 ($p < 0.001$), while DPPH radical scavenging activity also showed a significant increase to 7.91 ± 2.92, 14.59 ± 1.91

($p < 0.01$), 17.37 ± 1.46 ($p < 0.001$), and 31.54 ± 1.05 ($p < 0.001$). On the other hand, sensory evaluation indicated a decreasing trend in overall preference when more than 10% black soybean was added. Therefore, if the moisture content is increased, the texture part is also improved, and it is thought that the preference can be increased. As the number of health-conscious people increases, the rice cake using black soybeans used in this study is expected to be a health functional food. Since the main ingredient of rice cake is rice, it can be a concern due to its high carbohydrate content, but it can be seen that the addition of black soybeans used in the experiment provides nutritional supplementation due to its high protein and antioxidant functions. And I think people who don't like the texture of soy can eat it comfortably. Although black soybeans are a food that many people consume in Korea, it informs the functions and efficacy of black soybeans, which may be unfamiliar, and suggests that it would be good to study other foods in the future.

Author contributions

Soon Bok Won, Ji Ahn Han: Writing original draft preparation; Ji Ahn Han: review and editing; Ki Han Kwon: supervision and validation. The authors worked together in preparation of all sections of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

Ethical statement

All procedures performed in studies involving human participants were in accordance with the Ethical Standards of Sungkyul University and/or National Research Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Providing questionnaires to voluntarily participating workers is not perceived as a hazardous activity that needs special screening. The study was not a clinical trial, and the data are robustly anonymised and informed consent and thus did not require ethics committee approval.

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References

Academia Española de Nutrición y Dietética (2020) Academia Española de Nutrición y Dietética (la Academia) y el Consejo General de Colegios Oficiales de Dietistas-Nutricionistas. Recomendaciones de alimentación y nutrición para la población española ante la crisis sanitaria del COVID-19. [In Spanish] https://www.academianutricionydietetica.org/pro/noticias/recomendaciones-de-alimentacion-y-nutricion-para-la-poblacion-espano-la-ante-la-crisis-sanitaria-del-covid-19/ [Accessed on 03. 30. 2020]

Anderson RL, Wolf WJ (1995) Compositional changes in trypsin inhibitor, phytic acid, saponins and isoflavone related to soybean processing. The Journal of Nutrition 125: 581S–588S. https://doi.org/10.1093/jn/125.3_Suppl.581S

Baublis AJ, Lu C, Clydesdale FM, Decker EA (2000) Potential of wheat-based breakfast cereals as a source of dietary antioxidants. Journal of the American College of Nutrition 19: 308S–311S. https://doi.org/10.1080/07315724.2000.10718965

Bousquet J, Cristol JP, Czarlewski W, Anto JM, Martineau A, Haahtela T, Fonseca SC, Iaccarino G, Blain H, Fiocchi A, Canonica GW, Fonseca JA, Vidal A, Choi HJ, Kim HJ, Moing VL, Reynes J, Sheikh A, Akdis CA, Zuberbier T (2020) Nrf2-interacting nutrients and COVID-19: time for research to develop adaptation strategies. Clinical and Translational Allergy 10: 1–18. https://doi.org/10.1186/s13601-020-00362-7

Branen AL (1975) Toxicology and biochemistry of butylated hydroxyanisole and butylated hydroxytoluene. Journal of the American Oil Chemists's Society 52: 59–63. https://doi.org/10.1007/BF02901825

Carr AC, Maggini S (2017) Vitamin C and immune function. Nutrients 9: 1211. https://doi.org/10.3390/nu9111211

Chen YF, Chiang ML, Chou CC, Lo YC (2013) Enhancing the antitumor cell proliferation and Cu^{2+}-chelating effects of black soybeans through fermentation with *Aspergillus awamori*. Journal of Bioscience and Bioengineering 115: 400–404. https://doi.org/10.1016/j.jbiosc.2012.10.018

Choi MH, Seo YJ, Shin HJ (2017) Application of domestic bamboo stems mainly for inner beauty product development: A review. Korean Society for Biotechnology and Bioengineering 32: 1–8. https://doi.org/10.7841/ksbbj.2017.32.1.1

Choi SB, Jang JS, Park S (2005) Estrogen and exercise may enhance beta-cell function and mass via insulin receptor substrate 2 induction in ovariectomized diabetic rats. Endocrinology 146: 4786–4794. https://doi.org/10.1210/en.2004-1653

Choung MG, Baek IY, Kang ST, Han WY, Shin DC, Moon HP, Kang KH, (2001) Isolation and determination of anthocyanins in seed coats of black soybean (*Glycine max* (L.) Merr.). Journal of Agricultural and Food Chemistry 49: 5848–5851. https://doi.org/10.1021/jf010550w

Cianciosi D, Forbes-Hernández TY, Afrin S, Gasparrini M, Reboredo-Rodriguez P, Manna PP, Zhang J, Bravo Lamas L, Martínez Flórez S, Agudo Toyos P, Quiles JL, Giampieri F, Battino M, (2018) Phenolic compounds in honey and their associated health benefits: a review. Molecules 23: 2322. https://doi.org/10.3390/molecules23092322

Covinsky K, Katz M (2020) Supplemental nutrition assistance program – Do not take the food out of patients' mouth. JAMA Internal Medicine 180: 605–606. https://doi.org/10.1001/jamainternmed.2019.7151

Do JH, Kim KH, Jang JG, Yang JW, Lee KS (1989) Changes in color intensity and components during browning reaction of white ginseng water extract. Korean Journal of Food Science and Technology 21: 480–485. https://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE01796808

Do MH, Lee SS, Jung PJ, Lee MH (2007) Intake of fruits, vegetables, and soy foods in relation to breast cancer risk in Korean women: A case-control study. Nutrition and Cancer 57: 20–27. https://doi.org/10.1080/01635580701268063

Fiat AM, Migliore-Samour D, Jollès P, Drouet L, Bal dit Sollier C, Caen J (1993) Biologically active peptides from milk proteins with emphasis on two examples concerning antitrombotic and immunomodulating activities. Journal of Dairy Science 76: 301–310. https://doi.org/10.3168/jds.S0022-0302(93)77351-8

Ganesan K, Xu B (2017) Polyphenol-rich dry common beans (*Phaseolus vulgaris* L.) and their health benefits. International Journal of Molecular Sciences 18: 2331. https://doi.org/10.3390/ijms18112331

Gentile LF, Cuenca AG, Efron PA, Ang D, Bihorac A, McKinley BA, Moldawer LL, Moore FA (2012) Persistent inflammation and immunosuppression: a common syndrome and new horizon for surgical intensive care. Journal of Trauma and Acute Care Surgery 72: 1491–1501. https://doi.org/10.1097/TA.0b013e318256e000

Grant WB, Lahore H, McDonnell SL, Baggerly CA, French CB, Aliano JL, Bhattoa HP (2020) Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. Nutrients 12: 988. https://doi.org/10.3390/nu12040988

Han JA (2023) Consumer Behavior and Popularization Strategies for *Pistachia vera* L. Seolgi. PhD Thesis, SungKyul University, Anyang, Republic of Korea.

Hassan SM, Jawad MJ, Ahjel SW, Singh RB, Singh J, Awad SM, Hadi NR (2020) The Nrf2 activator (DMF) and covid-19: is there a possible role? Medical Archives 74: 134–138. https://doi.org/10.5455/medarh.2020.74.134-138

Hatano T, Edamatsu R, Hiramatsu M, Mori A, Fujita Y, Yasuhara T, Yoshida T, Okuda T (1989) Effects of the interaction of tannins with co-existing substances. VI.: effects of tannins and related polyphenols on superoxide anion radical, and on 1, 1-Diphenyl-2-picrylhydrazyl radical. Chemical and Pharmaceutical Bulletin 37: 2016–2021. https://doi.org/10.1248/cpb.37.2016

Hong JY, Shin SR, Kong HJ, Choi EM, Woo SC, Lee MH, Yang KM (2014) Antioxidant activity of extracts from soybean and small black bean. Korean Journal of Food Preservation 21: 404–411. https://doi.org/10.11002/kjfp.2014.21.3.404

Hui DS, Azhar EI, Madani TA, Ntoumi F, Kock R, Dar O, Ippolito G, Mchugh TD, Memish ZA, Drosten C, Zumla A, Petersen E (2020) The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health – The latest 2019 novel coronavirus outbreak in Wuhan, China. International Journal of Infectious Diseases 91: 264–266. https://doi.org/10.1016/j.ijid.2020.01.009

Hung YH, Huang HY, Chou CC (2007) Mutagenic and antimutagenic effects of methanol extracts of unfermented and fermented black soybeans. International Journal of Food Microbiology 118: 62–68. https://doi.org/10.1016/j.ijfoodmicro.2007.06.005

Hwang YR, Hwang ES (2015) Quality characteristics and antioxidant activity of Sulgidduk prepared by addition of aronia powder (*Aronia melanocarpa*). Korean Journal of Food Science and Technology 47: 452–459. https://doi.org/10.9721/KJFST.2015.47.4.452

Joung YM, Park SJ, Lee KY, Lee JY, Suh JK, Hwang SY, Park KE, Kang MH (2007) Antioxidative and antimicrobial activities of *Lilium* species extracts prepared from different aerial parts. Korean Journal of Food Science and Technology 39: 452–457. https://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE01710038

Jung YH, Han JS, Kim AJ (2019) Quality evaluation and antioxidant activity of inner beauty tea prepared from roasted lotus root and burdock. Asian Journal of Beauty & Cosmetology 17: 235–245. https://doi.org/10.20402/ajbc.2019.0285

Kang SA, Jang KH, Cho Y, Hong K, Suh JH, Choue R (2003) Effects of artificial stomach fluid and digestive enzymes on the aglycone isoflavone contents of soybean and black bean (*Rhynchosia molubilis*: Yak-Kong). The Korean Journal of Nutrition 36: 32–39. https://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE01650243

Kennedy AR (1995) The evidence for soybean products as cancer preventive agents. The Journal of Nutrition 125: 733–743. https://doi.org/10.1093/jn/125.3_Suppl.733S

Kim HK, Kim JN, Han SN, Nam JH, Na HN, Ha TJ (2012) Black soybean anthocyanins inhibit adipocyte differentiation in 3T3-L1 cells. Nutrition Research 32: 770–777. https://doi.org/10.1016/j.nutres.2012.06.008

Kim JH, Lee YT (2007) Quality characteristics and antioxidant activities of soybean curd products containing small black Soybean. Journal of the Korean Society of Food Science and Nutrition 36: 1431–1435. https://doi.org/10.3746/jkfn.2007.36.11.1431

Kim K, Lim KM, Kim CW, Shin HJ, Seo DB, Lee SJ, Noh JY, Bae ON, Shin S, Chung JH (2011) Black soybean extract can attenuate thrombosis through inhibition of collagen-induced platelet activation. The Journal of Nutritional Biochemistry 22: 964–970. https://doi.org/10.1016/j.jnutbio.2010.08.008

Kim SL, Son YK, Son JR, Hur HS (2001) Effect of germination condition and drying methods on physicochemical properties of sprouted brown rice. Korean Journal of Crop Science 46: 221–228. https://kiss.kstudy.com/Detail/Ar?key=4143762

Kim YH, Lee JH, Lee YS, Yun HT (2006) Antioxidant activity and extraction efficiency of anthocyanin pigments in black colored soybean. Korea Soybean Digest 23: 1–9. https://kiss.kstudy.com/Detail/Ar?key=2614317

Lee KH, Kim MJ, Kim AJ (2014) Physicochemical composition and antioxidative activities of *Rhynchosia nulubilis* according to Roasting Temperature. Journal of the Korean Society of Food Science and Nutrition 43: 675–681. https://doi.org/10.3746/jkfn.2014.43.5.675

Lee SH, Cho YJ, Kang SM (2017) Potential efficacy against anti-inflammation and wrinkle improvement of tyndallized *Lactobacillus rhamnosus* IDCC 3201 for inner beauty. Journal of Korean Beauty Society 23: 345–351. https://kiss.kstudy.com/Detail/Ar?key=3511253

Liao HF, Chen YJ, Yang YC (2005) A novel polysaccharide of black soybean promotes myelopoiesis and reconstitutes bone marrow after 5-flurouracil and irradiation-induced myelosuppression. Life Science 77: 400–413. https://doi.org/10.1016/j.lfs.2004.10.080

Lim SY (2010) Comparison of effect of various types of soybeans on mutagenicity and growth of human cancer cell lines. Journal of Life Science 20: 1532–1537. https://doi.org/10.5352/JLS.2010.20.10.1532

Lim SY, Park KY, Bae MS, Kim KH (2009) Effect of doenjang with black soybean on cytokine production and inhibition of tumor metastasis. Journal of Life Science 19: 264–270. https://doi.org/10.5352/JLS.2009.19.2.264

Lindgren E, Harris F, Dangour AD, Gasparatos A, Hiramatsu M, Javadi F, Loken B, Murakami T, Scheelbeek P, Haines A (2018) Sustainable food systems – a health perspective. Sustainability Science 13: 1505–1517. https://doi.org/10.1007/s11625-018-0586-x

Mendonca P, Soliman KFA (2020) Flavonoids activation of the transcription factor Nrf2 as a hypothesis approach for the prevention and modulation of SARS-CoV-2 infection severity. Antioxidants (Basel) 9: 659. https://doi.org/10.3390/antiox9080659

Pham TT, Shah NP (2007) Biotransformation of isoflavone glycosides by Bifidobacterium animalis in soymilk supplemented with skim milk powder. Journal of Food Science 72: M316–M324. https://doi.org/10.1111/j.1750-3841.2007.00476.x

Pycia K, Ivanišová E (2020) Physicochemical and antioxidant properties of wheat bread enriched with hazelnuts and walnuts. Foods 9: 1081. https://doi.org/10.3390/foods9081081

Qureshi AA, Mo H, Packer L, Peterson DM (2000) Isolation and identification of novel tocotrienols from rice bran with hypocholesterolemic, antioxidant, and antitumor properties. Journal of Agricultural and Food Chemistry 48: 3130–3140. https://doi.org/10.1021/jf000099t

Ravichanthiran K, Ma ZF, Zhang H, Cao Y, Wang CW, Muhammad S, Aglago EK, Zhang Y, Jin Y, Pan B (2018) Phytochemical profile of brown rice and its nutrigenomic implications. Antioxidants (Basel) 7: 71. https://doi.org/10.3390/antiox7060071

Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice-Evans C (1999) Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Radical Biology and Medicine 26: 1231–1237. https://doi.org/10.1016/S0891-5849(98)00315-3

Sa JH, Shin IC, Jeong KJ, Shim TH, Oh HS, Kim YJ, Cheung EH, Kim GG, Choi DS (2003) Antioxidative activity and chemical characteristics from different organs of small black soybean (Yak-Kong) grown in the Area of Jungsun. Korean Journal of Food Science and Technology 35: 309–315. https://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE02154742

Seo HM, Lee JH (2013) Physicochemical and antioxidant properties of yanggaeng incorporated with black sesame powder. Journal of the Korean Society Food Science and Nutrition 42: 143–147. https://doi.org/10.3746/jkfn.2013.42.1.143

Setchell KD, Cassidy A (1999) Dietary isoflavones: biological effects and relevance to human health. The Journal of Nutrition 129: 758S–767S. https://doi.org/10.1093/jn/129.3.758S

Shu XO, Zheng Y, Cai H, Gu K, Chen Z, Zheng W, Lu W (2009) Soy food intake and breast cancer survival. JAMA-Journal of The American Medical Association 302: 2437–2443. https://doi.org/10.1001/jama.2009.1783

Soto ME, Guarner-Lans V, Soria-Castro E, Manzano Pech L, Pérez-Torres I (2020) Is antioxidant therapy a useful complementary measure for COVID-19 treatment? An algorithm for its application. Medicina (Kaunas) 56: 386. https://doi.org/10.3390/medicina56080386

Taga MS, Miller EE, Pratt DE (1984) Chia seeds as a source of natural lipid antioxidants. Journal of the American Oil Chemists' Society 61: 928–931. https://doi.org/10.1007/BF02542169

Takahashi R, Ohmori R, Kiyose C, Momiyama Y, Ohsuzu F, Kondo K (2005) Antioxidant activities of black and yellow soybeans against low density lipoprotein oxidation. Journal of Agricultural and Food Chemistry 53: 4578–4582. https://doi.org/10.1021/jf048062m

Tsangalis D, Ashton JF, Mcgill AEJ, Shah NP (2002) Enzymic transformation of isoflavone phytoestrogens in soymilk by β-glucosidase-producing bifidobacteria. Journal of Food Science 67: 3104–3113. https://doi.org/10.1111/j.1365-2621.2002.tb08866.x

Tsoyi K, Park HB, Kim YM, Chung JI, Shin SC, Shim HJ, Lee WS, Seo HG, Lee JH, Chang KC, Kim HJ (2008) Protective effect of anthocyanins from black soybean seed coats on UVB-induced apoptotic cell death *in vitro* and *in vivo*. Journal of Agricultural and Food Chemistry 56: 10600–10605. https://doi.org/10.1021/jf802112c

Yi G, Din JU, Zhao F, Liu X (2020) Effect of soybean peptides against hydrogen peroxide induced oxidative stress in HepG2 cells via Nrf2 signaling. Food & Function 11: 3725–2737. https://doi.org/10.1039/C9FO01466G

Yim JH, Lee OH, Choi UK, Kim YC (2009) Antinociceptive and anti-inflammatory effects of ethanolic extracts of *Glycine max* (L.) Merr and *Rhynchosia nulubilis* Seeds. International Journal of Molecular Sciences 10: 4742–4753. https://doi.org/10.3390/ijms10114742

Zhishen J, Mengcheng T, Jianming W (1999) The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chemistry 64: 555–559. https://doi.org/10.1016/S0308-8146(98)00102-2

Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W [China Novel Coronavirus Investigating and Research Team] (2020) A novel coronavirus from patients with pneumonia in China, 2019. The New England Journal of Medicune 382: 727–733. https://doi.org/10.1056/NEJMoa2001017